Application for
UNITED STATES LETTERS PATENT

Of

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SEAT POSITION DETECTION DEVICE

TITLE OF THE INVENTION

Seat position detection device

CROSS REFERENCE TO RELATED APPLICATIONS

This application is based on and claims priority under 35 U.S.C. §119 with respect to a Japanese Patent Application 2003-108550, filed on April 14, 2003, the entire content of which is incorporated herein by reference.

FIELD OF THE INVENTION

This invention generally relates to a seat position detection device. More particularly, the present invention pertains to a seat position detection device detecting physical relationship between a stationary rail and a movable rail.

BACKGROUND OF THE INVENTION

An example of the seat position detection device is disclosed in U.S. Pat. No. 6,053,529. In this patent, a magnetic sensor is mounted so as to extend from a stationary rail mounted to a vehicle floor. The L-shaped sensor flange is attached upside down with a horizontal leg attached on a first end to the flange side of a movable rail attached in a slidable relationship with a stationary rail and on a second end attached to a downturn leg. Accordingly, the seat position is judged whether or not the downturn leg of the sensor flange is placed between the magnetic sensor and the magnetic body.

Another example of the seat position detection device is disclosed in Japanese Patent Laid-Open Publication No. 2003-19051. This seat position sensor also includes a magnetic sensor supported by a movable rail, a magnetic body supported by the movable rail as opposed to the magnetic sensor, and a flange provided between the magnetic sensor and the magnetic body. The L-shaped sensor flange is made of a plate-like magnetic body such as a steel plate, and adapted to underneath of a stationary rail. Namely, one plane of the flange is attached to the stationary rail, and the other plane thereof is located perpendicular to a floor. The seat position is judged whether or not the sensor

flange is placed between the magnetic sensor and the magnetic body.

In these two documents, the seat position detecting device can be took place without contacting in the detection system since a Hall element detects a change of the magnetic flux density generated from the magnet. However, a shielding member (the sensor flange or the flange) is provided such as a vertical wall in parallel with the stationary rail and the movable rail, and the shielding member is provided between the magnet and the Hall element. Thus, relatively large space is required to arrange the detection system.

In addition, another example of the seat position detection device is disclosed in Japanese Patent Laid-Open Publication No. 2002-200933. In this seat position sensor, sensor member is provided at a movable rail and includes a magnet and a Hall effect IC (magnetic sensor) accommodated in a case with L-shaped cross section. In this art, when the stationary rail is placed close to the sensor, the Hall effect IC can not detect a magnetic flux since the stationary rail intercepts the magnetic flux generated from the magnet. On the other hand, when the stationary rail is not close to lower rail by moving a seat to foreside, the Hall effect IC can detect a magnetic flux generated from the magnet.

The shielding member is not needed in this configuration. In this point, number of component may be reduced, and arrangement space may be reduced for the detection system. Although, if a magnet chip is accidentally adhered to the stationary rail, the Hall effect IC may be detect the magnetic flux generated at the magnet chip.

In addition, another example of the seat position detection device is disclosed in U.S. Pat. No. 4,909,560. This seat position sensor is applied in which the seat is movable along the slide direction using a driving force, and magnetism is used to estimate the seat position. In this art, a Hall effect IC (magnetic sensor) is mounted to a slide (movable rail), and a magnetic strip positioned close to the Hall effect IC is supported by track. The magnetic strip has a series of magnet poles of alternated polarity. Therefore, as a gear box including the Hall effect IC is moved backward and forward, the Hall effect IC passes in close proximity to each of the poles in the magnetic strip and switches its output transistor off and on as the IC passes the alternating north an south poles in the magnet strip. A

square wave generated by the Hall effect IC can be counted by a control module to provide the position data of the seat.

In this art, the seat position detecting device detects the seat position precisely. However, a control module is needed to judge the seat position by processing signals transmitted from the Hall effect IC. The control module counts signals transmitted from the Hall effect IC in response to seat movement, and memorizes the seat position. To memorize the seat position even when the main power is turned off, such as a semiconductor memory (for example, EEPROM (Electronically Erasable and Programmable Read Only Memory)) for saving the seat position data or a back up electric power supply are required. It makes the system complicated.

SUMMARY OF THE INVENTION

In light of foregoing, according to an aspect of the present invention, a seat position detection device includes a detection means for detecting physical relationship between a stationary rail supported by a vehicle body and a movable rail rigidly connecting a seat and sliding along the stationary rail wherein the detection means includes a magnetic body provided at one of the stationary rail and the movable rail and a magnetic sensor provided at the other of the stationary rail and the movable rail, and the magnetic body is arranged at an entire length of a specified region in sliding direction of the movable rail, and a magnetic pole thereof is directed perpendicular to the slide direction, and the magnetic sensor outputs a signal in response to magnetism from the magnetic body.

It is preferable that a sliding range of the seat is divided into two regions, and the magnetic body is attached to one of the divided region so that the magnetic sensor faces to one of the N pole and the S pole thereof.

It is still further preferable that the sliding range of the seat is divided into two regions, and the magnetic body includes two portions which are attached to one of the divided portion so that the magnetic sensor faces to one of the N pole and the S pole thereof, respectively.

It is still further preferable that the magnetic body is not exposed outside of the fixed rail or movable rail.

It is still further preferable that the magnetic body is shaped as a sheet.

It is still further preferable that the magnetic body is attached to one of the stationary rail and the movable rail by magnetic attraction.

It is still further preferable that the magnetic sensor includes a Hall element for outputting a signal according to magnetic flux density and a switching circuit for outputting a signal when a voltage level of the signal from the Hall element exceeds a predetermined value.

BRIEF DESCRIPTION OF THE DRAWING FIGURES

The foregoing and additional features and characteristics of the present invention will become more apparent from the following detailed description considered with reference to the accompanying drawing figures wherein:

Fig. 1 is a side view schematically illustrating a physical arrangement including a seat, a steering wheel, and a magnetic sensor according to a first embodiment of the present invention;

Fig. 2 is a block circuit diagram illustrating controlling system according to a first embodiment of the present invention;

Fig. 3 is a cross sectional view schematically illustrating a position of a Hall effect IC according to a first embodiment of the present invention;

Fig. 4 is a side view schematically illustrating a magnetic state generated from a magnet according to a first embodiment of the present invention;

Fig. 5 is a side view schematically illustrating physical arrangement of a magnet and a Hall effect IC as moving a movable rail according to a first embodiment of the present invention;

Fig. 6 is a side view schematically illustrating physical arrangement of a magnet and a magnetic sensor according to a second embodiment of the present invention;

Fig. 7 is a chart indicating detection signal and output of a Hall element according to a second embodiment of the present invention;

Fig. 8 is a side view schematically illustrating physical arrangement of a magnet and a Hall effect IC according to a third embodiment of the present invention;

Fig. 9 is a cross sectional view schematically illustrating physical arrangement of a magnet and a Hall effect IC according to a fourth embodiment of the present invention; and

Fig. 10 is a cross sectional view schematically illustrating physical arrangement of a magnet and a Hall effect IC according to a fifth embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

A preferred embodiment of the present invention will be described herein below in detail with reference to the accompanying drawings.

A first embodiment of the present invention is explained referring to Figs. 1 to 5.

As shown in FIG. 1, a seat 1 is provided in a vehicle body A, and a steering wheel 2 is provided in front of the seat 1. The seat 1 is supported on a floor 3 by a seat position adjusting mechanism B to adjust seat position backward and forward. The steering wheel 2 has an airbag device built-in.

A controlling system for operating the airbag is shown in FIG. 2. In the controlling system, signals from a speed sensor 6, a gravity sensor 7 and a Hall effect IC 8 (an example of magnetic sensor Se) are inputted to a control unit 5 (ECU), and the control unit 5 outputs a control signal into the airbag device 4.

The speed sensor 6 is a generic designation of detecting system that estimate

traveling speed of the vehicle body A according to condition of an accelerator, revolution speed of an engine, and condition of a transmission. The gravity sensor 7 functions so as to estimate impact energy applied to the vehicle body A, and then to output the impact energy as an electric signal. The Hall effect IC 8 functions so as to output a signal for judging the seat 1 location according to the magnetic intensity (magnetic flux density) generate from a magnet (magnetic body) M as described later. The airbag device 4 includes one airbag and two gas generation members to generate different gas amount each other. A signal path for operating each gas generation member is formed between the control unit 5 and both gas generation members.

The seat 1 includes a seat cushion 1A and a seat back 1B. The seat sliding range by the seat position adjusting mechanism B is divided into two regions at a control point P. For example, a first region provided in front side of the control point P is determined to as an unrestricted area X. On the other hand, a second region provided in backside of the control point P is determined to as a restricted area Y. The physical arrangement of the Hall effect IC 8 and the magnet M is set to that the Hall effect IC 8 outputs a detection signal while the seat 1 is located in the unrestricted area X. And also the Hall effect IC 8 does not output the detection signal while the seat 1 is located in the restricted area Y. Although the unrestricted area X and the restricted area Y have been indicated as almost same length as shown in FIG. 1, the ratio between them are not limited to this configuration as shown in FIG. 1.

The control unit 5 includes a microprocessor, and judges expansion level of the airbag depending on the seat position. When the airbag device 4 is worked in the case of that the Hall effect IC 8 judges that the seat 1 is in the unrestricted area X, the control unit 5 runs a process in which the airbag expands larger than the case of that the Hall effect IC 8 judges that the seat 1 is in the restricted area Y.

The Hall effect IC 8 (an example of the magnetic sensor Se) accommodates a Hall element and a switching circuit as a unit. The Hall element outputs a voltage signal according to magnetic flux density with a polarity according to direction of magnetic flux generated from the magnet M. The switching circuit outputs a detection signal when the voltage from the Hall element exceeds a predetermined threshold level, and does not output a detection signal (or output

connector outputs low voltage) when the voltage from the Hall element does not exceed a predetermined threshold level regardless of polarity of the voltage.

Simply, a Hall element or a MR element may be used as a magnetic sensor Se without using the Hall effect IC. In this case, a processing circuit is used to process a signal from the Hall element or the MR element in reference to the predetermined threshold.

The feature of the seat position detection device according to the first embodiment of the present invention is that the magnetic detection means includes the Hall effect IC 8 and the magnet M to act the magnetism to the Hall effect IC 8, and a detection apparatus includes the detection mean and a member supporting them.

A pair of stationary rails 10 is fixed to the floor 3 of the vehicle A through the intermediary of a bracket 11 provided at both front end and rear end of each stationary rail 10. A pair of movable rails 12 is attached to each stationary rail 10 with slidable relationship, and supports the seat 1. As shown in FIG. 3 and FIG. 5, stationary rails 10 are formed by bending of a steel plate (an example of magnetic material) to form a bottom portion 10a provided as horizontal posture, a pair of vertical wall portions 10b horizontally folded into upward at both sides of the bottom portion 10a, a pair of upper portions 10c horizontally folded to inward side at upper end of vertical wall portions 10b, and a pair of folding ends 10d folded into downward at the other end of upper portions 10c. Accordingly, an opening portion is formed between both folding ends 10d.

The movable rail 12 is also formed using steel plates (which is an example of magnetic material) formed including a vertical wall portion 12a lapped and jointed two steel plates by spot welding and so on, bottom portions 12b formed by bending lower ends of a pair of wall portions 12a to opposite direction each other, and folding ends 12c folded to upward at the other end of each bottom portion 12b. The movable rail 12 is inserted to inferior of the stationary rail 10, and plurality of free rotating rollers 13 are provided between the bottom portion 10a of the stationary rail 10 and the bottom portion 12b of the movable rail 12. Thus, the movable rail 12 is slidably supported along longitudinal direction of the stationary rail 10.

The seat position adjusting mechanism B is constructed as explained below. Plurality of hollow portions (not shown) is formed with a predetermined interval along longitudinal direction of the stationary rail 10. A lock member for engaging to one of the hollow portions is attached to the movable rail 12 with biasing to the engaging direction thereof by a spring. A handle 15 (see FIG. 1) is provided at front side of the movable rail 12 to operate engagement or disengagement between the lock member and one of the hollow portions. Accordingly, an operator can operate the handle 15 to release the locking condition of the seat position adjusting mechanism B and move the seat 1 in the longitudinal direction of the movable rail 12 (or stationary rail 11). Then, the operator can lock the seat position adjusting mechanism B by releasing the operation of the handle 15. In this time, the lock member is engaged with one of the hollow portions, and physical relationship between the stationary rail 10 and the movable rail 12 can be adjusted within predetermined interval.

The sheet type magnet M is provided to the top face of the upper portion 10c for one of the stationary rail 10. The magnet M is made of a flexible material including magnetized material (namely rubber type magnet), and single pole with N pole or S pole is formed on one side of the sheet type magnet M. The length of the magnet M attached to the stationary rail 10 corresponds to the unrestricted area X in the seat sliding range. As fastener means to attach the magnet M to the top face of the upper portion 10c, an adhesive material, a screw, a rivet and the like may be used. In addition, the magnet M may be attached to the stationary rail 10 by its own magnetic attraction. For example, the magnet may be attached to the stationary rail 10 wherein a convex portion formed at under surface of the magnet M is inserted to a concave portion formed on the stationary rail 10.

The Hall effect IC 8 is attached to the wall portion 12a for one of the movable rail 12, which corresponds to the stationary rail 10 attaching the magnet M. The Hall effect IC 8 is located upward of the magnet M to separate from the magnet M with a distance (height) D, and to overlap with the magnet M in plane view when the seat 1 is located in the unrestricted area X.

Although sensitivity of the Hall effect IC 8 to detect the magnet M is higher in

narrower distance between them (distance D shown in FIG. 3), the distance D may be set to few millimeter in consideration of power supplying to the Hall effect IC 8 and arrangement of a cable 8a to the wall portion 12a to transmit a detection signal. A protection cover, which is made of nonmagnetic material (for example, aluminum plate, cupper plate, resin plate and so on), may be provided at the wall portion 12a to cover the Hall effect IC 8.

As mentioned above, since the magnet M is provided at the stationary rail 10 made of magnetic material, the magnetic flux generated at lower surface side of the magnet M is conducted to a magnetic circuit composed of the stationary rail 10 as shown in FIG. 4. Accordingly, the magnetic flux is conducted to upper surface side of the magnet M with inhibiting the magnetic flux leakage to downward of the stationary rail. Then, magnetic flux density above the magnet M may be elevated, and detection sensitivity by the Hall effect IC 8 may become high. In addition, when a detection point of the Hall effect IC 8 is placed in front of the front end of the stationary rail 10 at seat 1 position adjusting, the magnetic flux generated from the magnet M may not affect the Hall effect IC 8 since front end of the magnet M and front end of the stationary rail 10 is approximately matched.

To utilize the function of the stationary rail 10 and the magnet M, the dimension of the magnet M in the back-and-forth direction is set to approximately match the dimension of the unrestricted area X as described above. Accordingly, the detection point of the Hall effect IC 8 is set to approximately match to the front end of the stationary rail 10 if location of the seat 1 is set to the control point P.

According to the configuration of the first embodiment, as shown in FIG. 5(a), if the location of the seat 1 is placed in the unrestricted area X, the Hall effect IC 8 detects the magnetism generated from the magnet M and outputs the detection signal since the Hall effect IC 8 is located above the magnet M. Accordingly, as shown in FIG. 5(b), if the location of the seat 1 is set in the restricted area Y, the Hall effect IC 8 may not output the detection signal since the Hall effect IC 8 may not detect the magnetism generated from the magnet M. For example, if the seat 1 is moved from the unrestricted area X to the restricted area Y, these two areas are accurately identified with a boundary (control point P) since the magnetic flux acting to the Hall effect IC 8 density is drastically changed when the Hall effect

IC 8 passes the control point. The Hall effect IC 8 outputs the detection signal if the magnetic flux density detected by the Hall effect IC 8 exceeds a set value without reference to either N pole or S pole. Thus, for example, if a magnet chip is accidentally adhered to the upper surface of the stationary rail 10, the Hall effect IC 8 may detect without mistake, and the position of the seat 1 may be identified preventing mistake.

A second embodiment of the present invention is explained referring to FIGs. 6, 7. (In the second embodiment, common numbers and symbols are used for parts having same functions with the first embodiment.)

In the second embodiment, configuration of the seat position detection device is changed from the first embodiment thereof. Configuration of the seat position adjusting mechanism B for supporting the seat 1 and control system operating the airbag device 4 is basically same as the first embodiment thereof.

Namely, as shown in FIG. 6, two magnets M, M are attached to upper surface of the upper portion 10c of the stationary rail 10 on either side of the control point. Magnets M, M are made of flexible material (namely rubber type magnet) with belt like shape and are placed according to the unrestricted area X and restricted area Y, respectively. One of the magnets M is attached to the stationary rail 10 at a corresponding position to the unrestricted area X wherein the upper surface acts as S pole. The other of the magnets M is attached to the stationary rail 10 at a corresponding position to the restricted area Y wherein the upper surface acts as N pole. The Hall effect IC 8 (magnetic sensor Se) is placed above each magnet M, M whole the adjusting range of the seat 1.

Although it is not shown in the figure, a unit of a Hall element and a switching circuit may be used as the magnetic sensor Se. In this configuration, for example, the Hall element outputs a voltage signal according to magnetic flux density with a polarity according to direction of magnetic flux generated from the magnet M. The switching circuit outputs a detection signal from one terminal when the positive voltage from the Hall element exceeds a predetermined threshold level, and outputs a detection signal from the other terminal when the negative voltage from the Hall element exceeds a predetermined threshold level. In addition, another configuration of the magnetic sensor Se may be used wherein the

magnetic sensor Se outputs a signal having a current value corresponding to one of Hi or Lo as a detection result of the Hall element.

According to the configuration of the second embodiment, for example, if the seat 1 is moved from the unrestricted area X to the restricted area Y, polarity of a voltage signal outputted from the Hall element changes from positive voltage to negative voltage on the basis of zero voltage, as shown in FIG. 7. The Hall element outputs the detection signal from one of the terminals corresponding to either the restricted area Y or unrestricted area X if the magnetic flux density detected by the Hall element exceeds a set value. Namely, if the location of the seat 1 is placed in the restricted area Y, the Hall element outputs the detection signal (Y) from one terminal. Accordingly, if the location of the seat 1 is placed in the unrestricted area X, the Hall element may output the detection signal (X) from the other terminal. Then, position of the seat 1 may be identified preventing mistake since the Hall effect IC 8 can receive high magnetic flux density whole adjusting range of the seat 1 position.

In particular, if a magnet chip is accidentally adhered to the upper surface of the magnet M, the polarity at upper surface of the magnet chip (facing the magnetic sensor Se) becomes same polarity as upper surface of the magnet M (facing the magnetic sensor Se). Then, effect of adhered magnet chip may be prevented, and detection of the seat 1 position may be identified preventing mistake.

In addition to above mentioned embodiments of the present invention, for example, embodiments explained below may be constructed. (In the second embodiment, common numbers and symbols are used for parts having same functions with the first embodiment.)

(A third embodiment)

In the third embodiment, the magnet M may be arranged to face at least two poles on upper surface along the unrestricted area X. For example, as shown in FIG. 8 both magnets M, M facing N pole and S pole at upper surface are adjacently arranged in the unrestricted area X on the stationary rail in the third embodiment. The Hall effect IC 8 is composed as same as the first embodiment thereof. Thus, any other combination of polarity of the magnet may be arranged since the Hall effect IC outputs a detection signal if the magnetic flux density is

high regardless of polarity of the magnet M.

(A forth embodiment)

As shown in FIG. 9, the magnet M may be attached to the vertical wall portion 12a of the movable rail 12, and the Hall effect IC 8 may be provided at the stationary rail 10. By supporting the Hall effect IC 8 to the fixed portion (stationary rail), the cable conducted from the Hall effect IC can be fixed to the fixed portion. Thus, there is no need to use flexible material for the cable 8a such as spiral type, and it may reduce cost for production and may improve reliability in use.

(A fifth embodiment)

In the fifth embodiment, a relative displacement system including the magnet M and the Hall effect IC 8 is provided in the stationary rail 10. More particularly, as shown in FIG. 10, the magnet M is attached to the folding end 12c of the movable rail, and the Hall effect IC 8 is provided at a nearby site of the magnet M and on the vertical wall portion 10b of the stationary rail 10 in which the Hall effect IC 8 is partially accommodated in the vertical wall portion 10b (whole the Hall effect IC 8 may be accommodated in the vertical wall portion 10b). In this manner, according to accommodate the magnet M and the Hall effect IC 8 to interior space of the stationary rail 10, the surface of the magnet M and the detector plane of the Hall effect IC 8 may be maintained to unpolluted state since adherence of dust is prevented to the surface of the magnet M and the detector plane of the Hall effect IC 8. In other wards, the magnet M and the Hall effect IC 8 are protected. In particular, to arrange the magnet m and the Hall effect IC 8 in interior space of the stationary rail 10, the magnet M may be provided at the side of the stationary rail 10, and the Hall effect IC 8 may be provided at the side of the movable rail 12 in addition to the arrangement shown in the FIG. 10.

The principles, a preferred embodiment and mode of operation of the present invention have been described in the foregoing specification. However, the invention which is intended to be protected is not to be construed as limited to the particular embodiment disclosed. Further, the embodiment described herein is to be regarded as illustrative rather than restrictive. Variations and changes may be made by others, and equivalents employed, without departing from the spirit of the present invention. Accordingly, it is expressly intended

that all such variations, changes and equivalents which fall within the spirit and scope of the present invention as defined in the claims, be embraced thereby.